WSDOT MITIGATION SITES
SOUTH CENTRAL REGION

2002 MONITORING REPORT

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South Central Region Annual Monitoring Report

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Executive Summary

The following tables summarize fifth year performance criteria as evaluated in the second or third year of monitoring (2002).

Site Name	Performance Criteria	2002 Results
SR 12 Naches River	≥ 50% aerial cover by woody species	32% ($CI_{80\%}$ = 25-38% cover)
	≥ 80% aerial cover in the emergent zone, with 60% native species	69% ($CI_{90\%}$ = 56-82% cover) 90% native species
	≥ 50% aerial cover of scrub shrub and forested plant species as listed in the mitigation plan	32% ($CI_{80\%}$ = 25-38% cover)
	≥ 80% aerial cover of emergent plants as listed in the mitigation plan	20% ($CI_{80\%}$ = 13-27% cover)

SR 823 Selah	≥ 50% aerial cover by woody species in the forested wetland	Macroplot 1: <1% (qualitative) Macroplot 2: <10% (qualitative)
	≥ 85% herbaceous cover in emergent zone; ≥ 65% cover by native species	Herbaceous: 69% ($CI_{80\%}$ = 58-81% cover) Native herbaceous: <1% (qualitative)
	Successful native vegetation plantings	NE: 26% ($CI_{80\%}$ = 21-30% survival) SW: 70% ($CI_{80\%}$ = 60-80% survival)

SR 970 Teanaway	≥ 1.7 plants per m^2 on the site[1]	East bank of Teanaway River: 0.58 plants/m^2 (total count)
		West bank of Teanaway River: 0.43 plants/m^2 (total count)
		Macroplot #1 (South): 0.29 plants/ m^2 ($CI_{80\%}$ = 0.2-0.4 plants/m^2)
		Macroplot #2 (North): 4.38 plants/m^2 ($CI_{80\%}$ = 3.5-5.3 plants/m^2)
	Control of non-native invasive plants	Qualitative Estimate: <10%

[1] This standard pertains to 2002. Revegetation monitoring will continue through 2004.

List of Acronyms

Acronym	Meaning
CI	Confidence Interval (see Methods and Glossary)
ECY	Washington State Dept. of Ecology
FAC	Facultative Indicator Status (Reed 1988)
FACW	Facultative Wetland Indicator Status (Reed 1988)
MP	Mile Post
OBL	Obligate Wetland Indicator Status (Reed 1988)
SR	State Route
USACE	U.S. Army Corps of Engineers
WDFW	Washington Department of Fish and Wildlife
WSDOF	Washington State Department of Fisheries
WSDOT	Washington State Department of Transportation

Introduction

History
Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) routinely evaluates the potential for degradation of critical areas that result from these infrastructure improvements. WSDOT strictly complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 89-10). Generally, mitigation sites are planned when transportation improvement projects adversely affect critical areas. The WSDOT Wetland Monitoring Program monitors these mitigation sites as a means of evaluating compliance with permit conditions and tracking overall development. Forty-two sites state-wide were monitored in 2002 (Map 1).

Purpose
The purpose of this document is to report the status of South Central Region WSDOT mitigation sites with respect to permit compliance and success standards for 2002 (Map 2). We rely on feedback from the users of this report to ensure its contents are clear, concise, and meaningful.

Process
Monitoring typically begins the first spring after a site is planted and continues for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years. In special cases sites may be monitored beyond the designated monitoring period.

Monitoring activities are driven by site-specific success standards detailed in the mitigation plan or permits. Data are collected on a variety of environmental parameters including vegetation, hydrology, and wildlife. When data analysis is complete, information on site development is communicated to region staff to facilitate management activities as part of an adaptive management process. Monitoring reports are issued to regulatory agencies and published on the web at:

www.wsdot.wa.gov/environment/eao/wetmon/default.htm

Methods

Methods used for monitoring mitigation sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.[2] The Monitoring Program's current methods include the following key elements:

Objective-based Monitoring

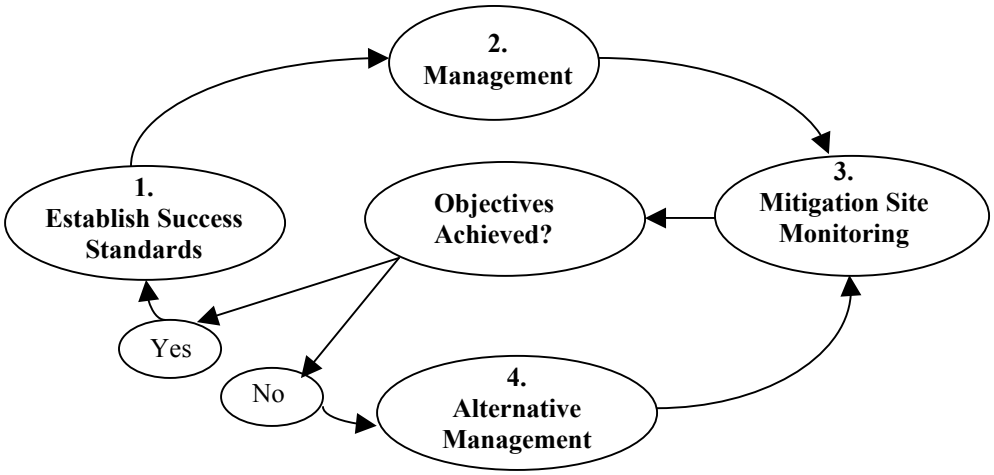
We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, permit requirements, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process includes four iterative steps:

1. success standards are developed to describe the desired condition,
2. management action is carried out to meet the success standard,
3. the response of the resource is monitored to determine if the success standard has been met, and
4. management is adapted if the standards are not achieved.

Monitoring is integral to the success of an effective adaptive management strategy. Without valid monitoring data, management actions may or may not result in improved conditions or compliance with regulatory permits. Timely decisions, based on valid monitoring data, result in increased efficiency and higher probabilities of success (Shabman 1995; Thom and Wellman 1996). The adaptive management process is illustrated in Figure 1.1.



(Redrawn from Elzinga et al. 1998).

Figure 1.1 The Adaptive Management Process

[2] These methods are based on techniques described in Bonham (1989), Elzinga (1998), Krebs (1999), Zar (1999), and other sources.

Statistical Rigor

The monitoring program strives to minimize subjectivity in data collection and increase the reliability of data collection and analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

Success Standards and Sampling Objectives

Site objectives and success standards are important elements of a mitigation plan. They indicate the desired state or condition of the mitigation site at a given point in time. Conditional permit requirements, if different from success standards in the mitigation plan, are also evaluated during monitoring activities. Some mitigation plans also provide contingencies if a specific undesirable condition occurs. Contingencies typically initiate a management response at the onset of a particular condition, for example, excessive cover by invasive species or insufficient cover by trees and shrubs.

Monitoring program staff thoroughly examine goals, objectives, success standards, and site permits to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in the mitigation plan or permit, clarification is sought from region staff.

Success standards are copied verbatim from the mitigation plan in the Success Standards and Sampling Objectives section of each site report. Several authors use the term "areal" differently than it has been used in many older mitigation plans.[3] We feel that the term "aerial" better describes the intent of the mitigation plans.[4] When "areal" is part of a success standard, we follow it with a (*sic*) notation. The glossary defines the meaning of these words as used in this document.

Information presented in the first table of each site report is obtained directly from the mitigation plan and permits, as appropriate.

Sampling may be required to address success standards unless an efficient and reliable total accounting of the target attribute can be conducted. Sampling objectives are developed to guide the data collection process. Sampling objectives typically include a confidence level and confidence interval half width.

The results of sampling are included in the individual site reports with the confidence level and confidence interval noted as ($CI_X = Y_1$-Y_2), where CI = confidence interval, X = confidence level, and confidence interval width is expressed as Y_1 low estimate to Y_2 high estimate. For example, an estimated aerial cover provided by woody species

[3] This distinction is based on definitions and usage in Bonham (1989), Hruby et al. (1999), and Williams (2001).

[4] Elzinga et al. (1998), Brower (1998), and Kent and Coker (1995).

reported as 65% ($CI_{80\%}$ = 52-78% aerial cover) means that we are 80% confident that the true aerial cover value is between 52% and 78% (Figure 1.2).

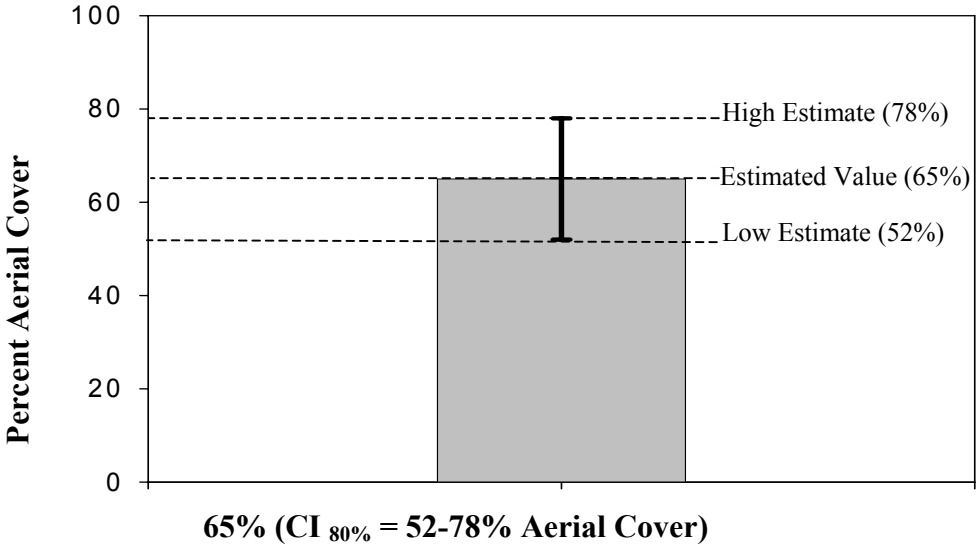


Figure 1.2 Estimated Cover Value Expressed with Confidence Interval Range

For compliance purposes, aerial cover calculations include only areas covered by rooted vascular plants (including floating-leaved species). Areas covered by thallophytes (algae, fungi, bacteria), bryophytes (mosses and liverworts), structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, most common names, and nativity used in this report were obtained from the *PLANTS Database* (USDA 2002). Hydrophytic plant indicator status was obtained from the *National List of Plant Species that Occur in Wetlands: Northwest* (Reed 1988 and 1993). Where invasive or noxious weeds are addressed, county specific listings in the *State Noxious Weed List* are referenced (Washington State Noxious Weed Control Board 2002).[5]

Sampling Design

When sampling is required, a sampling design is developed for the site or zone of interest. Sampling designs can vary from simple to complex depending on the number and type of attributes to be measured. Specific elements such as the size and shape of the site, the presence of environmental gradients, plant distribution patterns, and the amount of time and resources available for monitoring are factors that influence the sampling design. Elements of the sampling design may include the location of the baseline, orientation of transects (Figure 1.3), the method of data collection, and the number and type of sample units to be used. Depending on the sampling objective and site characteristics, transects may vary in number, length, and separation distance. Sampling transect locations are determined by using either a simple, systematic, stratified, or restricted random sampling method.

[5] In some cases, other nuisance species may be included in invasive cover estimates.

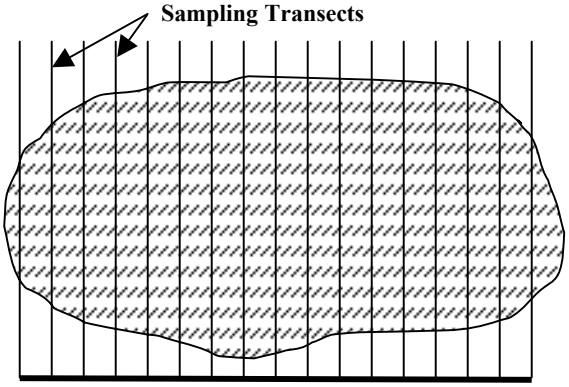


Figure 1.3 Baseline and Sampling Transects

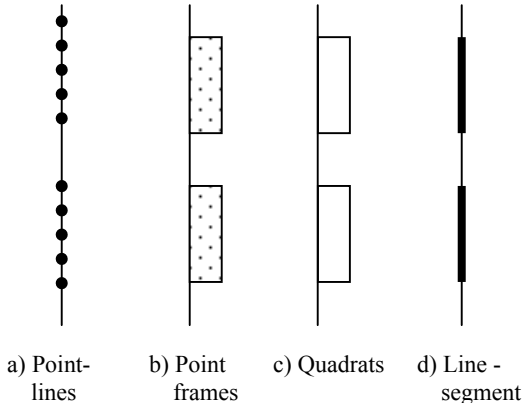


Figure 1.4 (a-d) Sampling Transects and Sample Units

A diagram showing the sampling design is typically included in mitigation site reports. Sample units appropriate to one or more of the methods described below are randomly located on or adjacent to the sampling transects (Figure 1.4 a-d). These drawings are general representations of the actual sampling designs and do not include specific details.

The Point-Line Method

The point-line technique (Bonham 1989; Elzinga et al. 1998) can be used where vegetative cover is an attribute of interest. This method involves randomly locating sample units consisting of fixed sets of points along sampling transects (Figure 1.4a). Tools used to collect point-line data include point-intercept devices, pin flags, or densitometers. These tools are used to identify point locations. Target vegetation intercepted by the point locator is recorded. If target species are not encountered on the point; bare soil, non-vascular plant, or habitat structure is recorded as appropriate. For each sample unit, cover is determined based on the number of times target vegetation is encountered divided by the total number of points. For example, if invasive species were encountered on 20 points from a sample unit composed of 100 points, the aerial cover of invasive species for that sample unit is 20%.

The Point-Frame Method

Point-frames are another tool that may be used to measure vegetative cover (Bonham 1989; Elzinga et al. 1998). A point frame is a rectangular frame that encloses a set of points collectively serving as a sample unit (Figure 1.4b).[6] The sample unit is lowered over herbaceous vegetation and data is recorded where target vegetation intercepts point locations. As with the point-line method, a cover value for each sample unit is determined. For example, if FACW and OBL species were encountered on 20 points in a point-frame composed of 40 points, the aerial cover of FACW and OBL species for that point-frame sample unit is 50%.

[6] The WSDOT Monitoring Program typically uses a frame formed with polyvinyl chloride (PVC). Strings span the frame lengthwise and points are marked on the strings using a standard randomization method.

Quadrat Method

To measure survival or density of planted trees and shrubs in an area, quadrat sample units are randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). Quadrat width and length are based on characteristics of the vegetative community and patterns of plant distribution. Quadrats are typically located lengthwise along sampling transects (Figure 1.4c). Plants within a quadrat are recorded as alive, stressed or dead. The success standard or contingency threshold can be addressed with a mean percent survival estimate of plantings, or a density per square meter of living plantings as appropriate. For example, if 8 planted woody species were recorded as alive and 2 were recorded as dead in a sample unit measuring 1 x 20 m, the survival of planted woody species for that sample unit would be 80%, and the density would be 0.4 live plants per square meter.

Line-Intercept Method

Cover data for the woody species community is collected using the line-intercept method (Bonham 1989; Elzinga et al.1998).[7] Line-segments, serving as sample units, are randomly located along sampling transects (Figure 1.4d). All woody vegetation intercepting the length of each sample unit is identified and the length of each canopy intercept recorded. For each sample unit, the sum of the canopy intercept lengths is divided by the total length to calculate an aerial cover value. For example, if woody vegetation was encountered on 80 meters from a 100 meter sample unit, the aerial cover for that sample unit is 80%.

Sample Size Analysis

With each of the above methods, sample size analysis is performed in the field to ensure that an adequate number of sample units are obtained to report the data at the specified confidence level and interval. The mean percent aerial cover value and standard deviation are calculated from the data, and sample size analysis is conducted. For data reported in this document, the following sample size equation for estimating a single population mean or a population total within a specified level of precision was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[8]
n = unadjusted sample size

A sample size correction to n is necessary for adjusting "point-in-time" parameter estimates.[9] It is the adjusted n value that reveals the number of sample units required to report the estimated mean value at a specified level of confidence.

[7] Depending on site conditions and other considerations, woody cover data may be collected using the point-line method and a densitometer.

[8] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

[9] Adjusted n values found in this report were obtained using the algorithm for a one-sample tolerance probability of 0.90 (Kupper and Hafner 1989; Elzinga et al 1998).

Wildlife Monitoring

Many mitigation plans include goals and objectives that address wildlife. For these sites, wildlife monitoring is conducted to provide information to support the results of the vegetation monitoring. An example of an objective that triggers such wildlife monitoring is presented below:

> Objective - Wildlife
> Wildlife cover and forage availability for birds and small mammals should increase substantially. The addition of fruit bearing shrubs and stumps, logs, and brush piles will increase habitat diversity and structure in the newly vegetated areas. Overall, creating an emergent and scrub-shrub wetland is intended to provide feeding, breeding, and resting habitat for birds, small mammals, and amphibians.

Some success standards contain more specific reference to monitoring wildlife. In these cases, a variety of wildlife monitoring techniques (see sections below) are used to evaluate success. An example of such a success standard follows:

> Success Standard:
> Development of habitat diversity and structure will be determined by the diversity and numbers of wetland dependent species identified during the monitoring period. The sites will meet this objective if wildlife species that utilize wetlands for some or all of their habitat requirements are located.

Incidental wildlife observations are recorded during all site visits.

Bird Monitoring

Sites with goals, objectives or success standards addressing the avian community receive three to four bird surveys conducted during the breeding season (April through mid-July). The point count method (Ralph et al. 1993) is used to document species richness and relative abundance.

Species diversity indices (H) may be calculated from bird survey data using the Shannon-Wiener function (Krebs 1999). Results are expressed as a mean annual species diversity index.

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to ith species

The following *t* test is used to test the null hypothesis that diversity indices from different years are equal (Zar 1999).

$$t = \frac{H'_1 - H'_2}{S_{H'_1 - H'_2}}$$

H' = index of species diversity
$S_{H'_1 - H'_2}$ = standard error of the difference between species diversity indices H'_1 and H'_2

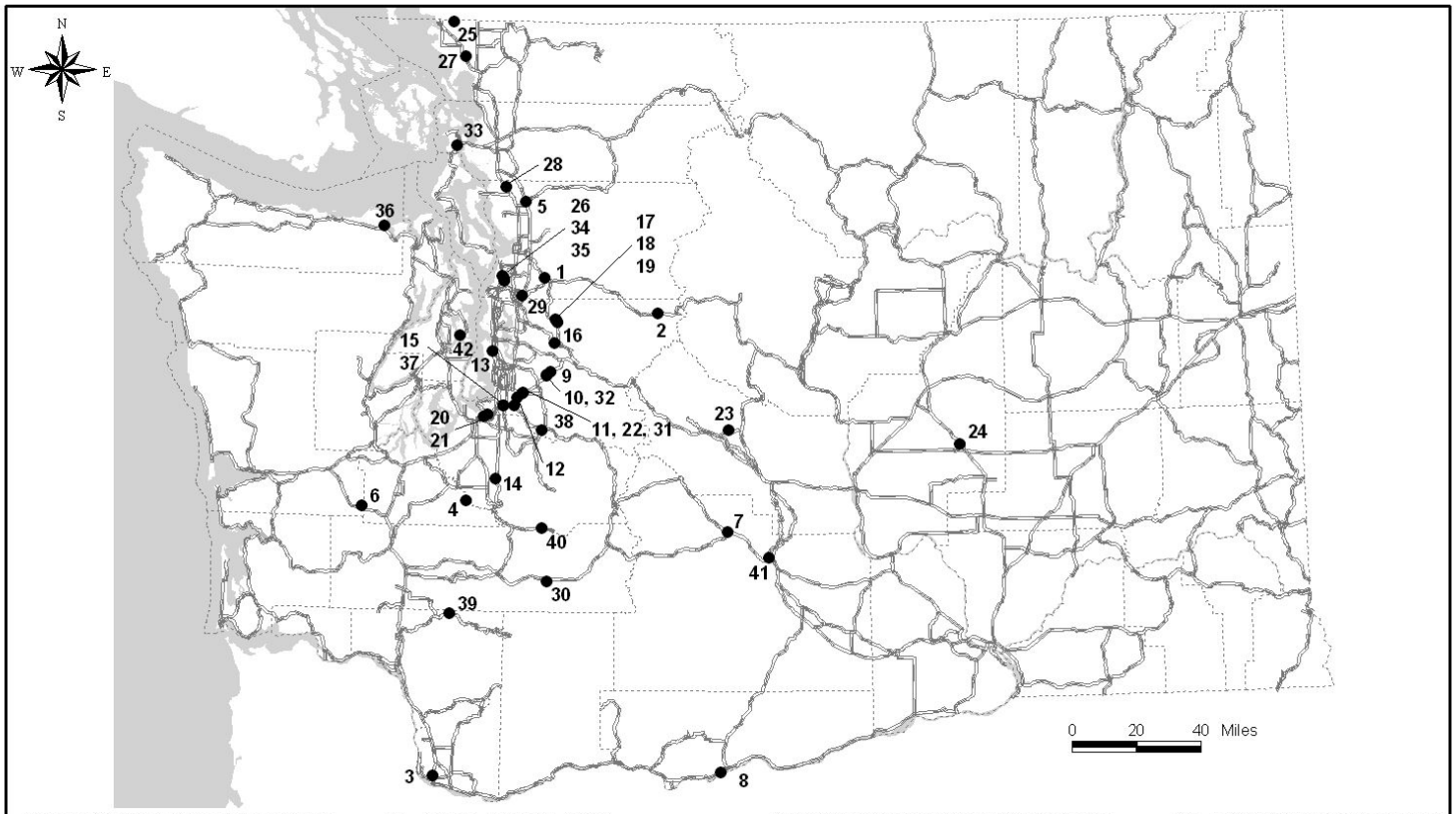
Amphibian Monitoring

Sites with goals, objectives, or standards referencing amphibians may be monitored using methods adapted from Olson et al. (1997). Methods may include funnel trapping on sites with a water depth of 1 dm or greater. Call surveys and area searches may be used to assess terrestrial components of sites without standing water. Incidental amphibian observations are recorded during other monitoring activities. Potential for amphibian habitat may be qualitatively assessed.

Hydrology Monitoring

Field indicators of wetland hydrology (Washington State Department of Ecology 1997) are recorded to address hydrology standards and to aid in future delineation efforts. Wetland mitigation sites are delineated after the last year of vegetation monitoring so that actual acreages can be compared to the planned wetland area.

Map 1: WSDOT Mitigation Sites Monitored in 2002



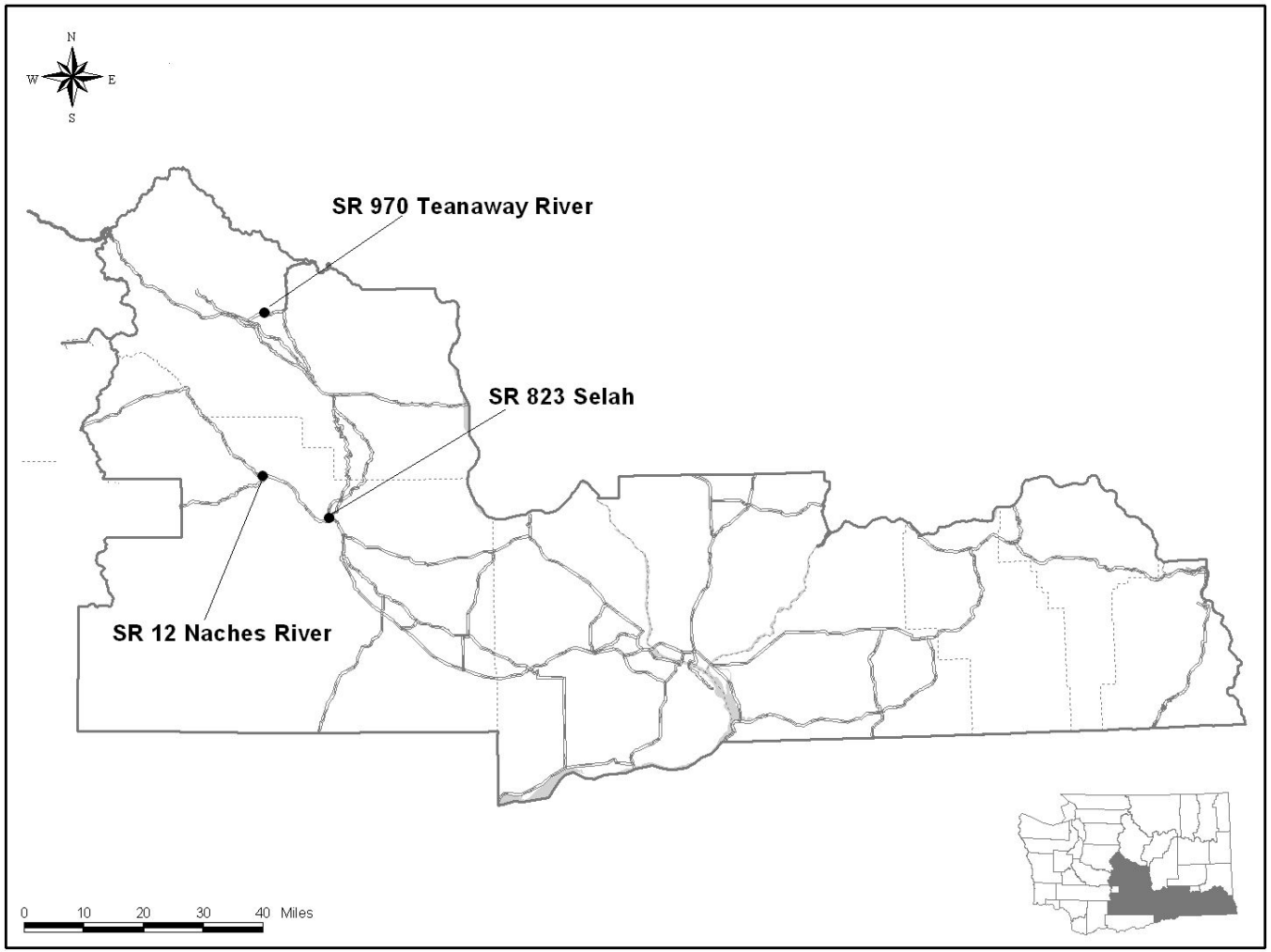
Sites with Formal Reports in 2002:

1 - SR 2 Monroe Fairgrounds
2 - SR 2 Profitt's Point
3 - SR 5 Burnt Bridge Creek
4 - SR 7 Nisqually
5 - SR 9 Stillaguamish R.
6 - SR 12 Black River
7 - SR 12 Naches River
8 - SR 14 Maryhill
9 - SR 18 Holder Creek #2
10 - SR 18 Issaquah-Hobart
11 - SR 18 Kendal
12 - SR 18 Pumpkin Patch
13 - SR 99 1st Avenue South Bridge
14 - SR 161 Kapowsin
15 - SR 167 Mill Creek Stage 1A
16 - SR 202 Dry Creek
17 - SR 203 Harris Creek
18 - SR 203 Morris Creek
19 - SR 203 Stillwater Hill Road
20 - SR 509 Erdahl Ditch
21 - SR 509 Hylebos Creek
22 - SR 516 Bartol
23 - SR 970 Teanaway River
24 - Moses Lake Mitigation Bank

Sites Monitored for Internal Feedback:

25 - SR 5 "H" Street Pit
26 - SR 5 Ash Way
27 - SR 5 Flame #2
28 - SR 5 Stanwood/Bryant WS
29 - SR 9 Howell Creek
30 - SR 12 Peter's Road
31 - SR 18 Frog Pond
32 - SR 18 Holder Creek #1
33 - SR 20 Campbell Lake Road
34 - SR 99 Lincoln Way
35 - SR 99 Manor Way
36 - SR 101 Sequim
37 - SR 167 Mill Creek Stage 2
38 - SR 410 Boise Creek
39 - SR 504 Kid Valley Rd
40 - SR 706 Ashford
41 - SR 823 Selah
42 - Schel-Chelb Estuary

Map 2: South Central Region Sites Monitored in 2002



Yakima County Sites

SR 12 Naches River, Yakima County

The following report summarizes monitoring activities completed by the Washington State Department of Transportation Wetland Monitoring Program at the SR 12 Naches River mitigation site in June 2002. Monitoring data were obtained to evaluate third year progress toward fifth year success standards. Activities included surveys of herbaceous and woody vegetation. Table 2.1 provides general site information and Table 2.2 shows this year's monitoring results.

Table 2.1 General Site Information for the SR 12 Naches River Mitigation Site

Project Name	SR 12 Naches River Bridge Replacement	
USACE Permit Number	94-4-00800	
Mitigation Location	SR 12 Bridge at the Naches River, Yakima County	
Township/Range/Section (impact)	T.15N/R.16E/S.35	
Monitoring Period	2000-2004	
Year of Monitoring	3 of 5	
Area of Project Impact	0.85 ha (2.09 ac)	
Type of Mitigation	Wetland Creation	Wetland Preservation
Area of Mitigation	0.09 ha (0.22 ac)	0.14 ha (0.34 ac)
Type of Mitigation	Buffer Creation	Buffer Enhancement
Area of Mitigation	0.16 ha (0.40ac)	0.06 ha (0.15 ac)

Table 2.2 Monitoring and Management Summary from SR 12 Naches River Mitigation Site

Performance Criteria	2002 Results[10]	Management Activities
Success Standards (2004)[11]		
1. At least 50% aerial cover by woody species	32% ($CI_{80\%}$ = 25-38% cover)	
2. At least 80% aerial cover in the emergent zone, with 60% native species	69% ($CI_{90\%}$ = 56-82% cover) 90% native species	Weed Control
Permit Requirements (2004)		
1. At least 50% aerial cover of scrub shrub and forested plant species as listed in the mitigation plan	32% ($CI_{80\%}$ = 25-38% cover)	
2. At least 80% aerial cover of emergent plants as listed in mitigation plan	20% ($CI_{80\%}$ = 13-27% cover)	Weed Control

[10] Estimated values are presented with their corresponding statistical confidence interval. For example, 32% ($CI_{80\%}$ = 25-38% cover) means we are 80% confident that the true aerial cover value is between 25% and 38%.

[11] Fifth year standards and permit requirements were evaluated in the third year for potential mid-course corrections.

Success Standards and Sampling Objectives

Fifth year success standards and requirements for the SR 12 Naches River mitigation site were excerpted from the *Final Wetland Mitigation Plan for SR 12 Naches River Bridge Replacement Bridge 12/320* (Smith and Russell 1996) and Department of Army Permit. A sampling objective follows the success standard and requirement. Appendix A provides the complete text of the success standards and permit requirements for this project.

Success Standard 1
Achieve 50% aerial cover of woody species in the scrub-shrub and forested zones of the SR12 Naches River mitigation site by 2004.

Permit Requirement 1
At least 50% aerial cover of scrub-shrub and forested plant species as listed in the wetland mitigation plan dated May 20, 1996 under "Buffer" and "Scrub/Shrub" (2004). [12]

> Sampling Objective 1
> To be 80% confident the true aerial cover of woody vegetation is within 20% of the estimated cover value.

Success Standard 2
Achieve at least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native (2004).

Permit Requirement 2
At least 80% aerial cover of emergent plants as listed in the wetland mitigation plan dated May 20, 1996 under "Emergent" (2004).

> Sampling Objective 2
> To be 80% confident the true aerial cover in the emergent zone is within 20% of the estimated cover value.

Methods

To evaluate cover of woody vegetation in the scrub-shrub and forested zones (Success Standard and Permit Requirement 1), 26 temporary transects were placed perpendicular to a 106 m baseline using a systematic random sampling method (Figure 2.1). Woody species cover data were collected using the line-intercept method in the scrub-shrub and forested zones. Data were collected on twenty-six 16m line-segment sample units. These sample units were randomly located along the sampling transects.

[12] A list of planted species is presented in Table 4 of Appendix A.

To address Success Standard 2 and Permit Requirement 2, aerial cover of herbaceous species was assessed in the emergent zone. Sixteen randomly positioned 0.5 x 1.0 meter point-frame sample units (30 points each) were placed along the sampling transects.

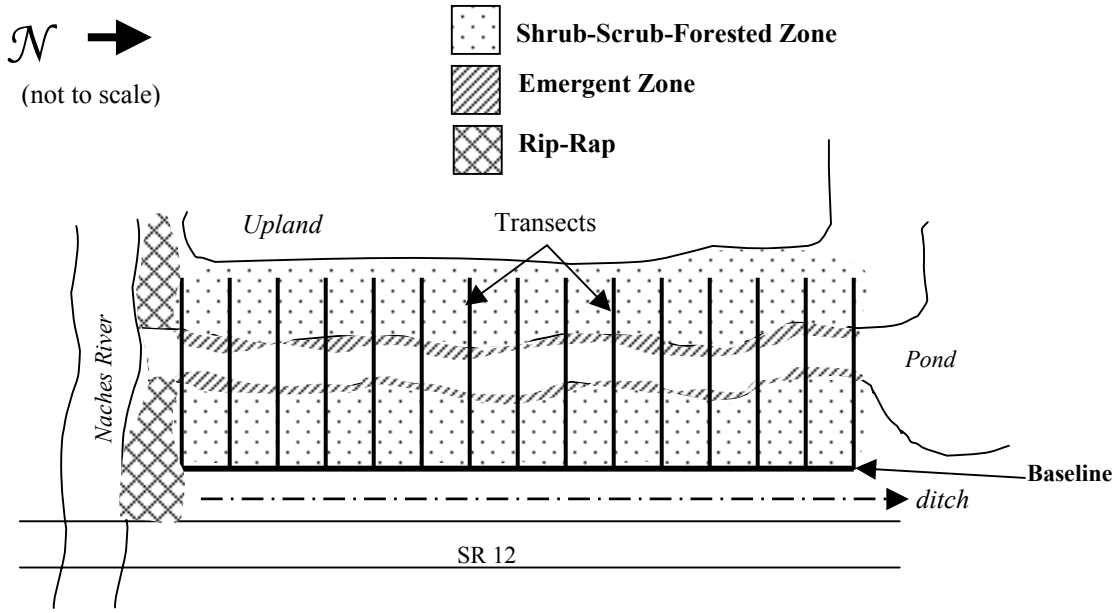


Figure 2.1 SR 12 Naches River Mitigation Site Sampling Design (2002)

The following sample size equation was used to perform statistical analysis on the collected data.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[13]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report.

Results and Discussion

Success Standard and Permit Requirement 1 – At Least 50% Woody Cover in the Scrub-Shrub and Forested Zones

The aerial cover provided by woody species was estimated to be 32% ($CI_{80\%}$ = 25-38% cover). Although the planted species provide very little cover, the volunteer species are well established on this site. If current trends continue, tree and shrub canopy may

[13] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

reach the 50% aerial cover requirement by 2004. Table 2.3 provides a list of the woody species on the site, and Figure 2.2 shows development of woody species in the Scrub-shrub zone.

Table 2.3 Woody Species at the SR 12 Naches Mitigation Site

Scientific Name	Common Name	Planted/Volunteer
Alnus rubra	red alder	Volunteer
Cornus sericea	redosier dogwood	Planted
Populus balsamifera	balsam poplar	Planted
Purshia tridentata	antelope bitterbrush	Volunteer
Robinia pseudoacacia	black locust	Volunteer
Rosa woodsii	Wood's rose	Planted
Sagittaria latifolia	broadleaf arrowhead	Volunteer
Salix species	Willows	Planted
Symphoricarpos albus	common snowberry	Planted

Success Standard 2 – At Least 80% Aerial Cover in the Emergent Zone, with at Least 60% Native Species

The aerial cover of vegetation in the emergent zone was estimated to be 69% (CI $_{90\%}$ = 56-82% cover). Native vegetation in the emergent zone provides an aerial cover of 62% ($CI_{80\%}$ = 51-74% cover). Native cover is provided mainly by *Poa palustris* (fowl bluegrass) and *Festuca idahoensis* (Idaho fescue). Continuing weed control has successfully limited cover by non-native species.

Figure 2.2 SR 12 Naches River Mitigation Site (June 2002)

Permit Requirement 2 - 80% Aerial Cover of Emergent Plants Listed in the Mitigation Plan

The aerial cover of emergent plants that are listed in the mitigation plan was estimated to be 20% ($CI_{80\%}$ = 13-27% cover). The species listed in the mitigation plan that were present in the emergent area are limited to *Carex* species (sedges).

In the third year, values for both Success Standard 2 and Permit Requirement 2 are below the 80% aerial cover requirement for year five. However, emergent native vegetation is well established on the site and is approaching the 80% cover requirement for year five. It appears unlikely that the more restrictive permit requirement will be met, because the species planted and listed in the mitigation plan have been replaced by other native species. Replanting the listed species does not seem necessary.

Management Activities

In 2002, weed control focused on *Cirsium arvense* (Canada thistle), *Verbascum thapsus* (common mullein), *Salsola tragus* (prickly Russian thistle), *Centaurea* species (knapweed) and *Cirsium vulgare* (bull thistle). Herbicides were applied to the site in June, July and August, and a power trimmer was used to cut weeds in August and September.

SR 823 Selah, Yakima County

The following report summarizes monitoring activities completed by the Washington State Department of Transportation Wetland Monitoring Program at the SR 823 Selah mitigation site in June 2002. Monitoring data were obtained to evaluate second year progress toward fifth year success standards and the contingency plan. Activities included surveys of herbaceous and woody vegetation. Table 3.1 provides general site information and Table 3.2 shows this year's monitoring results.

Table 3.1. General Site Information for the SR 823 Selah Mitigation Site

Project Name	SR 823, I-82 to Selah Interconnect	
USACE Permit Number	97-4-01450	
Mitigation Location	Harlan Landing at the Yakima River, Yakima County	
Township/Range/Section (impact)	T.13N/R.18E/S.12, SW/4, NW/4	
Monitoring Period	2001-2005	
Year of Monitoring	2 of 5	
Area of Project Impact	0.36 ha (0.88 ac)	
Type of Mitigation	Wetland Create/Enhance	Buffer Create/Enhance
Area of Mitigation	1.30 ha (3.20 ac)	0.32 ha (0.80 ac)

Table 3.2 Monitoring and Management Summary from SR 823 Selah Mitigation Site

Performance Criteria	2002 Results[14]	Management Activities
Success Standards (2005)[15]		
1. At least 50% aerial cover by woody species in the forested wetland	Macroplot 1: <1% (qualitative) Macroplot 2: <10% (qualitative)	Replanted
2. At least 85% herbaceous cover in emergent zone; at least 65% cover by native species	All herbaceous: 69% ($CI_{80\%}$ = 58-81% cover) Native herbaceous: <1% (qualitative)	Weed Control
Contingency Plan (2005)		
3. Successful native vegetation plantings	Macroplot 1: 26% ($CI_{80\%}$ = 21-30% survival) Macroplot 2: 70% ($CI_{80\%}$ = 60-80% survival)	Replanted

Success Standards and Sampling Objectives

Fifth year success standards for the SR 823 Selah mitigation site were excerpted from the *SR 82 Selah - Yakima Interconnect Final Wetland Mitigation Plan* (Watson and

[14] Estimated values are presented with their corresponding statistical confidence interval. For example, 69% ($CI_{80\%}$ = 58-81% cover) means we are 80% confident that the true aerial cover value is between 58% and 81%.

[15] Fifth year standards and permit requirements were evaluated in the second year for potential mid-course corrections.

Russell 1995). A sampling objective follows the success standard where appropriate. Appendix B provides the complete text of the success standards for this project.

Success Standard 1
The site will have attained ≥ 50% aerial cover by woody species in the forested and scrub-shrub zones of the wetland (2005).

Success Standard 2
The emergent zone will have an overall vegetative cover of greater than or equal to 85%, of which at least 65% of the herbaceous cover is composed of native species (2005).

> Sampling Objective 2
> To be 80% confident the true aerial cover of herbaceous species is within 20% of the estimated cover value in 2002.

Contingency Plan 3
Mitigation goals will be accomplished with successful native vegetation plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems.

> Sampling Objective 3
> To be 80% confident the true survival of planted species is within 20% of the estimated survival value in 2002.

Methods

To address Success Standard 1, a qualitative estimate of cover by woody species was deemed most appropriate. Quantitative data will be collected when woody species show greater development.

Success Standard 2 and Contingency Plan 3 were addressed quantitatively. In order to prevent impacts to the preserved area in the middle of the site, 2 macroplots were placed on either side of the preserved area to evaluate the vegetative community (Figure 3.1). In Macroplot 1, a systematic random sampling method was used to place 18 temporary sampling transects along a 160m baseline (Baseline 1). These transects were extended perpendicular to the baseline and ended at the edge of the preserved area. In Macroplot 2, 26 temporary transects were similarly placed along a second baseline of 152m (Baseline 2).

To address Success Standard 2, the emergent zone was evaluated for aerial cover of herbaceous species using the point-line method. Data were collected on 21 sample units (each 80 points distributed along a 20 m interval) randomly located along sampling transects.

To evaluate the woody species survival Contingency Plan 3, quadrat sample units were randomly located along sampling transects in both macroplots. Data were collected on

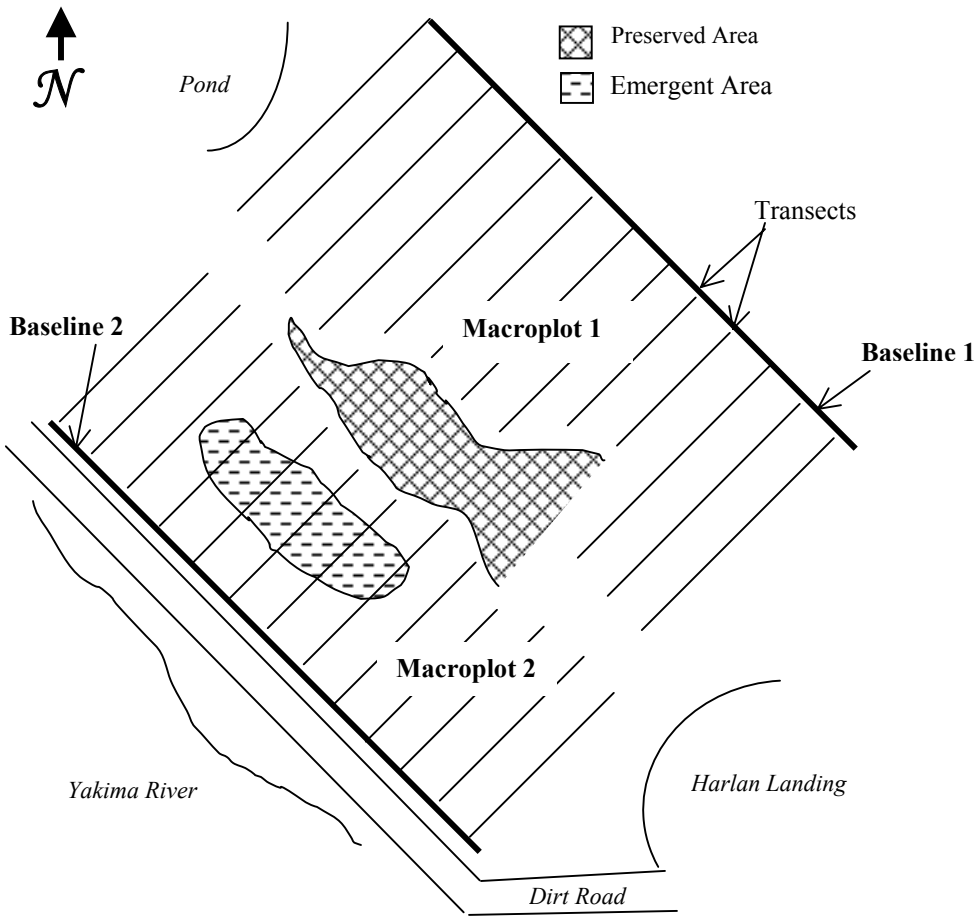


Figure 3.1 SR 823 Selah Mitigation Site Sampling Design (2002)

29 quadrat sample units (2x30 m) randomly placed along sampling transects in Macroplot 1. Data were collected on 26 quadrat sample units (1x50 m), randomly placed along sampling transects in Macroplot 2.

To address the survival of planted woody species, data were collected on 54 quadrat sample units (1 x 20m) randomly placed along sampling transects. Empty planting holes were counted as dead individuals.

In addition to addressing performance criteria, data were gathered to guide site management activities with regard to invasive species. Data were collected on aerial cover of invasive species using the point-line method. Twenty-nine point-line sample units of length 30 m were randomly placed along sampling transects in Macroplot 1. Data were obtained at 60 point locations on each sample unit. Twenty-two point-line sample units of length 50 m were randomly placed along sampling transects in Macroplot 2. Data were obtained at 100 point locations on each sample unit.

The following sample size equation was used to perform sample size analysis on the collected data.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[16]
n = unadjusted sample size

For additional details on the methods described above, see the Methods section of this report.

Results and Discussion

Success Standard 1 –50% Woody Cover in the Scrub-Shrub and Forested Zones (2005)
In year 2 of 5, based on qualitative estimates, the aerial cover provided by woody species in Macroplot 1 is less than 1%, and less than 10% in Macroplot 2. Past droughts and lack of access to irrigation have had a deleterious effect on survival and growth of planted woody species.

Success Standard 2 –85% Herbaceous Cover in the Emergent Zone with 65% Cover by Native Species (2005)
Cover by all herbaceous species was estimated to be 69% ($CI_{80\%}$ = 58-81% cover) (Figure 3.2). Cover by native herbaceous species was estimated to be less than 1% (3 out of 1615 data points). *Hordeum jubatum* (foxtail barley) and *Eleocharis ovata* (ovate spikerush) were the two native species encountered. None of the seven planted emergent species were observed. Non-native herbaceous species providing most of this cover included *Bromus tectorum* (cheatgrass), *Chenopodium* sp. (goosefeet), and *Echinochloa crus-galli* (barnyard-grass).

Figure 3.2 SR 823 Selah Mitigation Site Macroplot 2 (June 2002)

[16] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Additional cover (qualitatively estimated to be 15%) in the emergent zone is provided by the following recently planted native woody species: *Cornus sericea* (redosier dogwood) and *Salix exigua* (narrowleaf willow).

Contingency Plan 3- Successful Native Vegetation Plantings

The survival estimate for planted woody species is 26% ($CI_{80\%}$ = 21-30% survival) in Macroplot 1, and 70% ($CI_{80\%}$ = 60-80% survival) in Macroplot 2. Species observed include: *Salix* spp. (willows), *Rosa* sp. (roses), *Cornus sericea* (redosier dogwood), *Crataegus douglasii* (black hawthorne), *Symphoricarpos albus* (common snowberry), *Acer* sp. (maples), *Malus fusca* (Pacific crabapple), *Populus* sp. (cottonwoods), and *Sambucus nigra* (blue elderberry). Since the survival in Macroplot 1 has been so poor, parts of this area were excavated after monitoring, and re-planted so the root zone is closer to the water table.

Additional Monitoring

Aerial cover by undesirable species was estimated to be 35% ($CI_{80\%}$ = 28-42% cover) in Macroplot 1 and 15% ($CI_{80\%}$ = 11-18% cover) in Macroplot 2. Invasive species present on the site included *Kochia scoparia* (Mexican-fireweed), *Phalaris arundinacea* (reed canarygrass), and *Cirsium vulgare* (bull thistle). Continuing weed control measures and recent excavation may decrease the cover of invasives and allow desirable plants to flourish.

Management Activities

The site was sprayed and weeded in June and July, and re-planted in August and October 2002 (after monitoring). In addition, portions of the site were excavated so that the roots of emergent plants would be closer to the water table. Table 3.3 summarizes management activities at this site.

Table 3.3 SR 823 Selah Summary of Management Activities

Date	Description of Management Activity
2002	Excavated, sprayed, weeded, and re-planted
2001	Re-planted 12,000 native plants and removed 1500 cu yd of poor soil
2000	Invasive species control – mechanical (pulling/cutting) and herbicide

Kittitas County Sites

SR 970 Teanaway, Kittitas County

The following report summarizes monitoring activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 970 Teanaway mitigation site in July 2002. Monitoring data were obtained to compare to third year success standards. Activities include vegetation surveys. Table 4.1 provides general site information and Table 4.2 summarizes this year's monitoring results.

Table 4.1 General Site Information for the SR 970 Teanaway Mitigation Site

Project Name	SR 970 Teanaway River Bridge
USACE Permit Number	97-4-01124
Mitigation Location	Teanaway River, Cle Elum, Kittitas County
Township/Range/Section (impact)	T.20N/R.15E/S.25
Monitoring Period	2000 to 2004
Year of Monitoring	3 of 5
Area of Project Impact	4.90 ha (12.12 ac)
Type of Mitigation	Restoration

Table 4.2 Monitoring Summary from the SR 970 Teanaway Mitigation Site

Performance Criteria	2002 Results[17]	Management Activities
Permit Requirements 1 (Special Condition h) (2002)		
1. $\geq$ 1.7 plants per m^2 on the site	**East bank of Teanaway River:** 0.58 plants/m^2 (total count)	
	West bank of Teanaway River: 0.43 plants/m^2 (total count)	
	Macroplot #1 (South): 0.29 plants/ m^2 ($CI_{80\%}$ =0.2-0.4 plants/m^2)	Irrigation
	Macroplot #2 (North): 4.38 plants/m^2 ($CI_{80\%}$ =3.5-5.3 plants/m^2)	Irrigation
Permit Requirements 2 and 3 (Special Condition e) (2002)		
2. Control of non-native invasive plants	Qualitative Estimate: <10%	Weed Control

[17] Estimated values are presented with their corresponding statistical confidence interval. For example, 0.29 plants/m^2 ($CI_{80\%}$ = 0.23-0.35 plants/ m^2) means we are 80% confident that the density value is between 0.23 and 0.35 plants/m^2.

Permit Requirements and Contingency Plan

Third year permit requirements for the SR 970 Teanaway mitigation site were excerpted from the U.S. Army Corps of Engineers (USACE) permit 97-4-01124 (1997). A companion sampling objective follows the Permit Requirement 1 (Special Condition (h)). Appendix C provides a complete text of the monitoring-related permit requirements for this project.

Permit Requirement 1 (Special Condition h)
An 80% survival rate shall occur at the end of the third year monitoring period (2002).

Note: 80% survival is interpreted as a density of 1.7 stems per square meter on the site. This allows both volunteer and planted woody species to be included (James Morin personal communication, April 2001).

> Sampling Objective
> To be 80% confident the true woody plant density is within 20% of the estimated survival value in 2002.

Permit Requirement 2 (Special Condition e)
Control of non-native invasive plants during the 5-year vegetation monitoring period (2000-2004).

Methods

A total count of woody plants was conducted in both the east and west bank re-vegetation areas in order to calculate density values. Area was calculated based on the total width and length of each re-vegetation area along the river corridor.

To evaluate woody plant density in the stream channel relocation area, sampling was conducted. Since the pattern and distribution of woody plants is different in the north and south end of this sampled area, two macroplots were used to improve the efficiency of the sampling design (Figure 4.1).

Density of woody species in the stream channel relocation area was measured using a systematic random sampling method to place forty-five transects along a 154m baseline. Quadrats (1×40m each) were randomly positioned along each transect. In each quadrat, planted woody species were identified and counted as living or dead.

Sample size analysis confirmed that sufficient sampling had been completed based on the sampling objective and the desired level of statistical confidence. The following sample size equation was used to perform this analysis on the collected data.

$$n = \frac{(z)^2(s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[18]
n = unadjusted sample size

A qualitative assessment of invasive plant species cover was conducted for the entire site.

For additional details regarding methods, see the Methods section of this report.

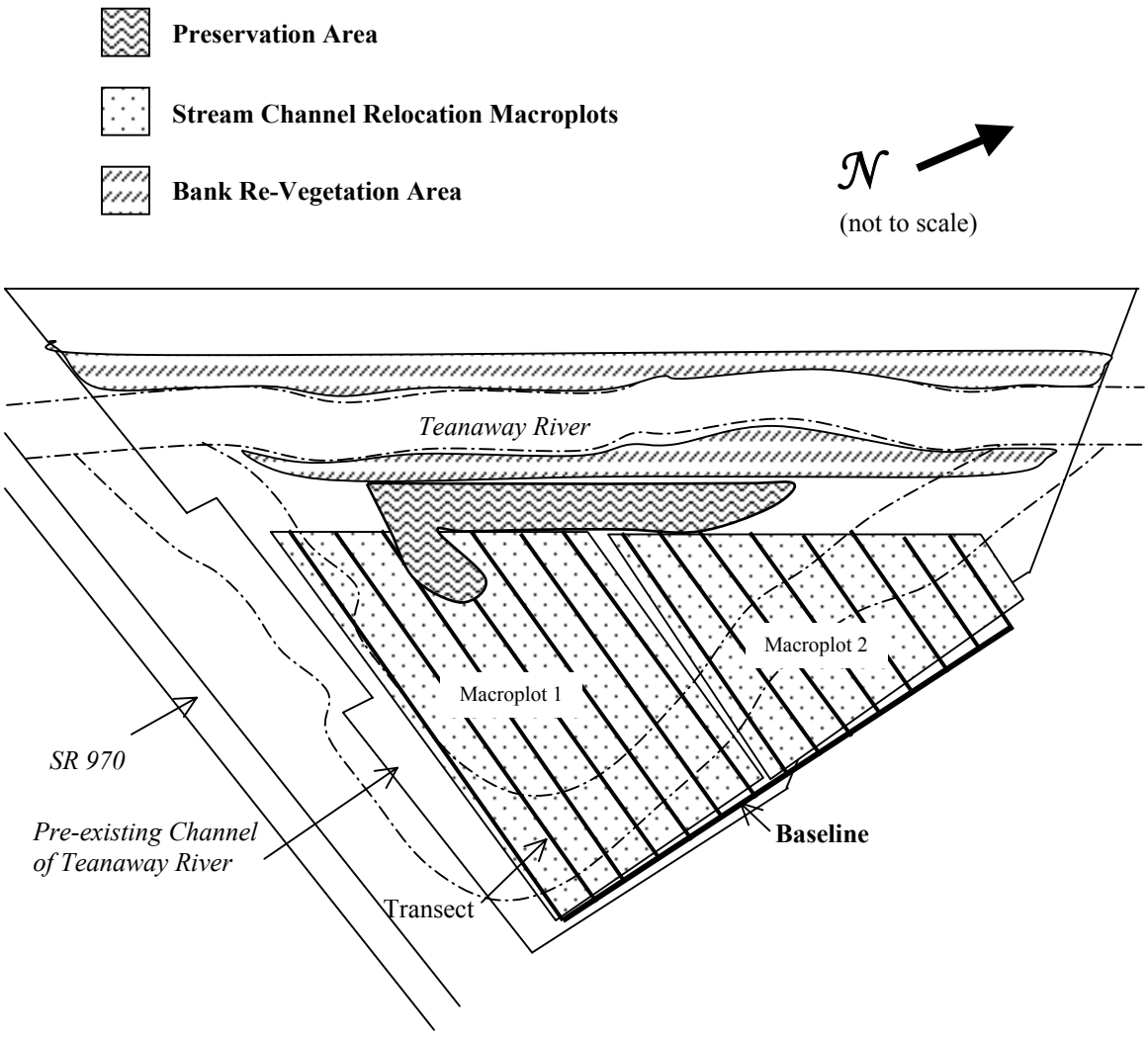


Figure 4.1 SR 970 Teanaway Mitigation Site Sampling Design (2002)

[18] The precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

Results and Discussion

Figure 4.2 SR 970 Teanaway Mitigation Site

Permit Requirement 1 – At least 1.7 plants/m^2

Density of woody species in the re-vegetation area along the east bank of the Teanaway River was 0.58 plants/m^2. This value does not meet the 1.7 plants/m^2 target specified in the permit. Periods of high runoff and peak water flow have altered parts of the riverbank in this re-vegetation zone; therefore, woody plant establishment is occurring at a slower rate than expected.

In re-vegetation areas along the west bank, the density of woody species was 0.43 plants/m^2. Although this is below the 1.7 plants/m^2 target specified in the permit, volunteer *Populus balsamifera* (black cottonwood) and *Salix* species (willows) are starting to colonize this area. If this portion of the riverbank does not erode further during periods of high runoff and peak flow, density in this area should approach the permit requirement in the next couple of years.

Replanting re-vegetation zones along the east and west banks of the Teanaway River may not be practical for two reasons. First, erosion of riverbank material is a natural process that occurs yearly during high and periodic peak flows. Plant establishment may be difficult to achieve in these areas. Second, *P. balsamifera* and *Salix* species seedlings are colonizing some of the more stable areas of the riverbank. If colonization continues, replanting may not be necessary.

In the stream channel relocation area, woody species density is estimated to be 0.29 plants/m^2 ($CI_{80\%}$ =0.2-0.4 plants/m^2) in Macroplot 1. This estimate falls below the 1.7 plants/m^2 target specified in the permit. Plantings at the south end of Macroplot 1 appear stressed and some plant die-off may have occurred since summer 2001. However, *P. balsamifera* and *Salix* species seedlings have colonized areas at the north end of this macroplot. In these areas, irrigation has helped encourage plant establishment. More irrigation may be necessary between the secondary channel and areas of preserved trees to increase the rate of growth and natural recruitment in this zone.

Macroplot 2 (Figure 5.2) in the stream channel relocation zone has an estimated density of 4.38 plants/m^2 ($CI_{80\%}$ =3.5-5.3 plants per m^2). This density estimate exceeds the 1.7 plants/m^2 requirement. This is due, primarily, to the high numbers of *P. balsamifera* seedlings that have colonized areas of the secondary stream channel in this portion of the mitigation site.

Permit Requirement 2 – Control of Non-Native Invasive Plants

The aerial cover of non-native invasive species on the mitigation site is less than 10% (qualitative estimate). Ten non-native invasive species were identified during monitoring visits in 2002. Species of primary concern include: *Cardaria chalapensis* (lensepod whitecress), *Centaurea diffusa* (diffuse knapweed), and *Melilotus alba* (white sweetclover). These three species were present at relatively high cover levels. Weed control activities have been effective in the past and are recommended for continued control of invasive species.

The following invasive species are present on the mitigation site at relatively low cover levels:

- *Centaurea debeauxii* (meadow knapweed)
- *Cirsium arvense* (Canada thistle)
- *Cirsium vulgare* (bull thistle)
- *Hypericum perforatum* (common St. Johnswort)
- *Leucanthemum vulgare* (oxeye daisy)
- *Phalaris arundinacea* (reed canarygrass)
- *Verbascum thapsus* (common mullein)

Management Activities

South Central Region staff plan to continue irrigation and weed control.

Appendices

Appendix A

SR 12 Naches River Success Standards

The following success standards are excerpted from the *Final Wetland Mitigation Plan for SR 12 Naches River Bridge Replacement Bridge 12/320* (Smith and Russell 1996). The standards addressed this year are identified in **bold** font.

Mitigation Goals
The goals of the mitigation project replace the lost functions and values of the impacted wetlands, and provide a combination of diverse out-of-kind enhancements. WSDOT proposes to create 0.09 hectares (0.40 acres) of buffer, preserve 0.06 hectares (0.15 acres) of buffer, and preserve 0.14 hectares (0.34 acres) of existing wetland. It is intended that wetland and buffer creation and preservation will produce an ecologically diverse system, providing wildlife habitat and food chain support, surface water discharge, flood runoff attenuation in very large flood events, sediment/toxicant retention, and nutrient removal and transformation. These functions will enhance the riparian ecosystem of the Naches River corridor.

Objectives and Standards of Success
Objective: Create a wetland and riparian corridor community vegetated with a diverse mix of wetland and riparian plant species indigenous to the local area.

Standards of Success:
After five years

> **a. 50% aerial cover of woody species in the scrub-shrub and forested zones of the site.**
>
> **b. at least 80% aerial cover of vegetation in the emergent zone, of which 60% of the species are native**.

Contingency Plans
Mitigation goals will be accomplished with native plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems. Determinations of success of plantings and overall vegetation of the site will be guided by standards of success as stated.

In the event that aerial coverage of wetland forest, scrub-shrub, or emergent vegetation falls short of the listed performance standards, (i.e., year 5) the site will be replanted to bring it up to levels stated. The DOT environmental staff will coordinate with appropriate agencies to agree on remedial action.

Table 4. Planting list.

Zone:	Species	Placement
Buffer	Ponderosa pine (*Pinus ponderosa*)	top of bank
	Smooth sumac (*Rhus trilobata*)	edge of bench to toe of road
	Woods rose (*Rosa woodsii*)	edge of bench to toe of road
	black cottonwood (*P. balsamifera*)	middle of bench to toe of road
	snowberry (*Symphoricarpos alba*)	edge of bench to top of bank
	native erosion control dry grass mix (sp. varies)	edge of bench to top of bank
Scrub/Shrub	black cotton wood (*P. balsamifera*)	channel slope to edge of bench
	pacific willow (*S. lasiandra*)	channel slope to edge of bench
	red stemmed willow (*Salix* sp.)	channel slope to edge of bench
	red osier dogwood (*C. stolonifera*)	emergent to middle of bench
	sandbar willow (*Salix exigua*)	middle to edge of bench
	wild iris (*Iris missouriensis*)	emergent to toe of road
Emergent	spike rush (*Eleocharis palustris*)	emergent to middle of bench
	local sedge (*Carex* sp.)	emergent to middle of bench
	sm. fruited bulrush (*S. microcarpus*)	emergent to middle of bench
	pondweed (*Potamogeton* sp.)	emergent

NOTE – All plantings and cuttings to be taken from local area if possible.

Additional Permit Requirements

Excerpted from the U. S. Army Corps of Engineers Nationwide Permit 96-4-00800 (Department of the Army 1996).

Special Condition E

Vegetation at the 5 year monitoring inspection will meet at least 50% aerial cover of scrub-shrub and forested plant species as listed in Table 4 of the wetland mitigation plan dated May 20, 1996 under "Buffer" and "Scrub/Shrub".

Special Condition F

Vegetation at the 5 year monitoring inspection will meet at least 80% aerial cover of emergent plants as listed in Table 4 of the wetland mitigation plan dated May 20, 1996 under "Emergent".

Appendix B

SR 823 Selah Success Standards

Excerpted from Watson, A. M., and E. Russell. 1995. *SR 82 Selah – Yakima Interconnect Final Wetland Mitigation Plan* dated Sept. 25, 1995, revised Dec 20, 1995. Washington State Department of Transportation Environmental Affairs Office.

Mitigation Goals

The goals of wetland mitigation are to replace the lost functions and values of the impacted wetlands. WSDOT proposes to create 1.30 hectares (3.2 acres) of mixed palustrine forested/ scrub-shrub/ emergent wetland and .33 ha (.80 acres) of buffer. In addition a buffer area of .17 ha (.41 acres) would be preserved. It is intended that creation of the wetland will produce an ecologically diverse system providing wildlife habitat & food chain support, ground water discharge, flood attenuation in very large flood events, sediment/ toxicant retention and nutrient removal & transformation. These functions will enhance the riparian ecosystem of the Yakima River corridor.

Because this site has the potential for some contact by park users, an interpretive sign is being developed for prominent placement in the mitigated area. This sign will contain basic wetland ecology information and a request to leave the wetland area undisturbed.

Objectives and Standards of Success

Objective: Create a wetland community vegetated with a diverse mix of wetland and riparian plant species similar to those natural to the area.

Standards of Success: ***after five years***

- **The site will have attained greater than or equal to 50% cover by woody species in the forested and scrub-shrub zones of the wetland.**
- **The emergent zone will have an overall vegetative cover of greater than or equal to 85%, of which at least 65% of the herbaceous cover is composed of native species.**

Contingency Plans

Mitigation goals will be accomplished with successful native vegetation plantings. Contingency plans will include replanting the site in case of planting failure or other unforeseen problems.

In the event that aerial coverage of wetland forest, scrub-shrub or emergent vegetation falls short of the listed performance standards, additional measures will be employed to assure the establishment of a viable wetland plant community at the site. These measures include regrading the site in the event that the hydrology is too deep or otherwise insufficient for plant success.

Construction and Planting

Vegetation to remain on the site as an island will be protected during site construction with temporary fencing placed at the edge of the drip lines. Detailed instructions for evacuation, placement of soil amendment, plant materials and plant spacing are provided in Appendix F. As-built plans will be provided to the WSDOT Environmental office responsible for plan development and monitoring. The mitigation site will be fenced on all sides to discourage disturbance by park users or other people.

Monitoring

The wetland mitigation site will be monitored by a WSDOT biologist at the following times: after grading, (before planting); after planting; and approximately one year after planting. The first two visits will focus on verification that the site is being developed as specified in the mitigation plans. If errors are found, remediation will be required before additional work may be completed. The third visit, approximately one year after final planting, will include description and rough mapping of plant communities, observations of wildlife and hydrology, and documentation with color photos. If it is determined at that time that the wetland is in need of remedial work, specific suggestions will be noted for follow-up action by WSDOT.

Appendix C

SR 970 Teanaway Permit Requirements

The following is excerpted from the Department of the Army Permit 97-4-01124.

Permit Requirements:

Special Condition e: A contingency plan shall be developed by WSDOT which will detail the following: actions to be taken in the event of adverse weather conditions during construction, a plan for the control of non-native invasive plants during the 5-year vegetation monitoring period, and a plan for replanting plants which do not meet the survival criteria specified in condition (h).

Special Condition h: Invasive plant control shall occur as specified in the contingency plan described in condition (e). An 80% survival rate shall occur at the end of the first, second, and third year monitoring periods. If 80% survival is not obtained, plants shall be replanted in the next planting season following the monitoring period where lack of survival was determined.

Note: 80% survival is interpreted as a density of 1.7 stems per square meter on the site. This allows both volunteer and planted woody species to be included. (James Morin personal communication, April 2001).

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the amount of ground covered by vegetation of a particular species or suite of species when viewed from above. Aerial cover is expressed as a percentage. Values for aerial cover are typically obtained from point-line, point-frame, or line intercept data.

Areal estimates – are made using the known boundary of a feature or statistical population. Areal estimates are often expressed in units of area.

Aquatic vegetation – includes submerged and rooted (*Elodea*, *Myriophyllum*) or floating (non-rooted) plants (*Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar, Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Canopy cover – the coverage of foliage canopy (herbaceous or woody species) per unit ground area**.**

Community – a group of populations of species living together in a given place and time.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width.

Cryptogam – any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of plants per unit area (typically square meters).

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) device that includes horizontal and vertical leveling and a mirror to locate a precise vertical point in space either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.

Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – A plant that interferes with management objectives on a specific site at a specific point in time (Whitson et al. 2001). For monitoring purposes, invasive species include those listed on the current County Noxious Weed List, and on a site-by-site basis, other species may be included (such as *Rubus armeniacus* (Himalayan blackberry)).

Line-segment –a linear sample unit that is used to measure vegetative cover.

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats, line-segments or point-lines (Elzinga et al. 1998).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point Intercept Device – a tripod that supports a rod that can be leveled and lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which inferences are made.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance (birds) – the number of individuals per unit of sampling effort.

Relative Cover – The proportion of specific target vegetative cover compared to that of all the vegetative species in the community combined (Brower et al. 1998).

Restricted Random Sampling Method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly

positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives provide a complement to success standards and describe the desired level of precision for sampling. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than 6m (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified Random Sampling Method – The population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic Random Sampling Method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – For vegetation surveys, the transect is a line used to assist in the location sample units (point-lines, quadrats, line segments or frames) across the monitoring study area.

Tree – a woody plant that at maturity is usually 6m (20 feet) or more in height and generally has a single trunk, unbranched for 1m or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

Wetland-dependent species (birds) – restricted in temporal or spatial distribution to wetlands based on an intrinsic feature or features of the environment (Finch 1989).

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